CLAIMS

1. An electron beam apparatus, in which an electron beam emitted from an electron gun having a cathode and an anode is focused and irradiated onto a sample and secondary electrons emanated from said sample are directed into a detector, said electron beam apparatus characterized in further comprising means for optimizing irradiation of said electron beam from said electron gun onto said sample.

2. An electron beam apparatus claimed in Claim 1, wherein said optimizing means includes two-stage deflectors disposed in proximity to said electron gun, wherein said two-stage deflectors are adapted to deflect and direct an electron beam emitted from said cathode in a specific direction so as to be in alignment with an optical axis direction of said electron beam apparatus, said electron beam emitted in the specific direction being at a certain angle with respect to the optical axis due to the fact that, among crystal orientations of said cathode, a specific crystal orientation allowing a higher level of electron beam emission is out of alignment with the optical axis direction.

3. An electron beam apparatus as claimed in claim 2, wherein one deflector of said two-stage of deflectors, which is disposed closer to said electron gun, is designed to be an electromagnetic deflector and the other deflector of said two-stage of deflectors, which is disposed in closer to said sample, is designed to be an electrostatic

deflector.

4. An electron beam apparatus as claimed in claim 2, wherein the crystal of said cathode is composed of carbide, boride or nitride of transition metals.

5. An electron beam apparatus as claimed in claim 1, wherein said optimizing means comprises said cathode, an anode having a potential near to that of said cathode and said anode, wherein only an electron beam that has been emitted in a particular direction among a plurality of electron beams emitted in different directions from said electron gun is guided onto said sample, and the electron beams emitted in the directions other than said particular direction are absorbed into said anode having a potential near to that of said cathode and thus discarded.

6. An electron beam apparatus as claimed in claim 1, wherein said secondary electrons emanated from an electron beam irradiated region on a surface of the sample are detected so as to evaluate the sample, wherein said sample has a partial region on the surface thereof which is relatively weak against dielectric breakdown which may be caused by electron beam irradiation, wherein said optimizing means is constituted as means for controlling irradiation of said electron beam so as not to be irradiated onto said weak region but to be irradiated exclusively onto the other regions.

7. An electron beam apparatus as claimed in claim 6, wherein a region having a gate oxide film of a transistor formed thereon and a region having an electric connection

with said region of gate oxide film are selected as said relatively weak regions against said dielectric breakdown.

8. An electron beam apparatus as claimed in claim 6, wherein scanning operation of the electron beam is adapted to be applied over an entire surface of the sample, while said electron beam may be blanked when said electron beam is to scan said region relatively weak against said dielectric breakdown.

9. An electron beam apparatus as claimed in claim 1, wherein said secondary electrons emanated from an electron beam irradiated region on a surface of the sample are detected so as to evaluate the sample, wherein a surface of a sample is segmented into a region relatively weak against dielectric breakdown and the other regions, wherein said optimizing means is constituted as means for controlling said irradiation of said electron beam so that a different dose levels of electron beam is applied to each of said respective different regions so as to evaluate the surface of the sample.

10. An electron beam apparatus as claimed in claim 1, wherein said electron beam emitted from said electron gun having a thermionic emission cathode is irradiated against an aperture and the electron beam after having passed through said aperture is contracted and projected onto said sample, two-stage of deflectors is operated to scan said sample, and secondary electrons emanated from the sample are accelerated by an electric field produced by an objective lens and guided by an E x B separator into said

detector, wherein said optimizing means is constituted as means for setting a pivot point of deflection by said two-stage deflectors in such a location that minimizes a transverse chromatic aberration in the proximity of said objective lens.

11. An electron beam apparatus as claimed in claim 1, wherein said electron gun is operative under a space charge limited condition.

12. An electron beam apparatus as claimed in claim 10, wherein said aperture is square shaped.

13. An electron beam apparatus as claimed in claim 11, wherein a negative voltage is applied to said sample and a voltage having a lower potential than that of said sample is applied to a lower electrode of said objective lens.

14. An electron beam apparatus as claimed in claim 1, wherein said electron beam apparatus comprises an electron optical system which produces a decelerating electric field for a primary electron beam between an objective lens and said sample so that a focused electron beam can scan a surface of said sample, in which secondary electrons emanated from said sample, after having passed through said objective lens, are deflected from said optical system so as to be detected, wherein said optimizing means is constituted as means for establishing such a dimensional relationship as represented by an expression:

$$W+D/2 \leqq 5\ \text{mm}$$

where "W" is a working distance of said objective lens, and "D" is a bore diameter of an electrode of said objective

lens disposed in a location closest to said sample.

15. An electron beam apparatus as claimed in claim 1, wherein said electron beam apparatus is composed as a one which can evaluate a flat wafer within a range defined as an inner side with respect to the periphery of said wafer by a distance not smaller than "R" mm, by using an electron optical system having an objective lens of decelerating electric field type, wherein said optimizing means is constituted as means for establishing such a dimensional relationship as represented by an expression:

$$W+D/2 \leqq R\text{mm}.$$

where "W" is a working distance of said objective lens, and "D" is a bore diameter of an electrode of said objective lens disposed in a closest location to said sample.

16. An electron beam apparatus as claimed in claim 1, wherein at least said objective lens has an electrode of axisymmetric structure made of an insulating material with a metal coating applied selectively onto a surface thereof.

17. An electron beam apparatus as claimed in any of claims 14 to 16, wherein a plurality of electron optical systems having the features of claim 16 is arranged in parallel above a sheet of sample.

18. An electron beam apparatus as claimed in claim 1, wherein said electron beam apparatus has an electron optical column configured such that an electron beam emitted from a thermionic emission cathode may be irradiated against said sample and either one of secondary electrons, back scattered electrons or absorbed electrons,

which has been emanated from said sample, is detected in a detecting system, wherein said optimizing means is constituted as means for determining a value for a heating electric power of said thermionic emission cathode by evaluating a signal/noise ratio or a noise level detected in said detecting system during a period when said electron beam is irradiated against said sample while changing the heating electric power of said thermionic emission cathode.

19. An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is determined in such a manner that said signal/noise ratio exceeds a predetermined value or said noise level is not greater than a predetermined value when a certain level of beam current is applied to the sample from the electron beam emitted from said thermionic emission cathode.

20. An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is determined in such a manner that an increasing rate of said signal/noise ratio with respect to the heating electric power is not greater than a predetermined value or a decreasing rate of said noise level is not greater than a predetermined value when a certain level of beam current is applied to the sample from the electron beam emitted from said thermionic emission cathode.

21. An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said

thermionic emission cathode is determined by evaluating a noise current/beam current ratio.

22. An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is tentatively determined in such a manner that a variation in an electron gun current observed during the period when the heating electric power of said thermionic emission cathode being changed is moderate, and following the tentative determination, the value for the heating electric power of said thermionic emission cathode is ultimately determined based on an evaluation of the signal/noise ratio or the noise level detected in said detecting system.

23. An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is determined in consideration of a relationship between the heating electric power of said thermionic emission cathode and said signal/noise ratio and another relationship between the heating electric power of said thermionic emission cathode and a lifetime of said thermionic emission cathode.

24. A device manufacturing method, wherein an electron beam apparatus as defined in either of claim 1 ~~to 23~~ is used to evaluate a wafer in the course of processing or a wafer of a finished product.